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**Statement of Dr. Charles L. Jackson**  
**Strategic Policy Research**  
**Before the Federal Communications Commission**  
**Personal Communications Services Task Force Meeting**

**April 12, 1994**

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**Statement of Interest**

I am an engineer with substantial experience with spectrum management policy and mobile radio. As a consultant I have had many clients in the mobile industry. Several studies I have authored or co-authored have been filed in the PCS proceeding by Bell Atlantic.

I am appearing here today expressing my own views, which are not necessarily those of Strategic Policy Research or of any client of Strategic Policy Research.

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**Statement of Dr. Charles L. Jackson**  
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**April 12, 1994**

**I. Background and Qualifications**

My name is Charles L. Jackson. I am currently a principal at Strategic Policy Research, a consulting firm specializing in telecommunications. By training I am an engineer with experience in communications systems and digital systems. I have been a consultant for the last 13 years. Before my consulting career, I worked as Staff Engineer at the House Communications Subcommittee and at the FCC as Special Assistant to the Chief of the Common Carrier Bureau and as Engineering Assistant to Commissioner Glen Robinson. Prior to government service, I worked as an engineer on communications and computer systems. I hold a Ph.D. degree in Electrical Engineering from the Massachusetts Institute of Technology.

While working in the Common Carrier Bureau, I conducted a study of the possibility of a digital cellular service. While working for the House Subcommittee, I was responsible for spectrum issues including cellular issues. As a consultant, I managed the preparation of several cellular applications for U.S. markets, assisted in the preparation of one application in Europe and consulted with several firms about the likely evolution of mobile technology and markets. I was part of the team that consulted with the government in New Zealand in 1988 and designed, in large part, the spectrum property rights system now used in New Zealand. During the last two years, I have consulted for the European Community on issues such as voice telephony. I have written extensively on spectrum management policy.

**II. Introduction**

I also appeared at the FCC's *en banc* hearing on PCS in December 1991. As preparation for today's meeting, I reviewed my comments at that earlier meeting. My first reaction was how far we have come. Many of the difficult issues that were unsettled then appear to have been resolved. The Commission has found spectrum for PCS. The Commission has decided to make significant spectrum available for unlicensed PCS, while reserving the bulk of PCS spectrum for licensed PCS services. Congress has authorized the use of auctions to choose PCS licensees—a legislative step which should speed the distribution of PCS licenses—and has set forth a regulatory structure for mobile radio services which avoids a difficult choice between private carriage and common carriage. But, significant steps still remain before the promise of PCS can be fulfilled.

My most important message that day was

The PCS proceeding is the most important proceeding before the FCC today. Working on it will be perplexing and difficult, but this time is worthy of your time and effort.<sup>1</sup>

I still hold this view. While there are many important issues in telecommunications, there are few where the FCC is so completely in control and where the stakes for our nation are so large.

In the limited time I have available today, I will comment briefly on several of the larger policy issues that remain in dispute. Specifically, I will offer my observations on:

- the geographical extent of licenses,
- the bandwidth of licenses,
- problems created by the split of PCS into upper and lower bands,
- the role of standardization,
- the proper location of unlicensed PCS, and
- the impact of microwave incumbents on PCS buildout.

### **III. Geographical Extent**

I think the Commission has made a healthy move in picking the relatively large BTAs and MTAs to define the geographic scope of PCS license regions. I don't think the Commission has gone far enough. The recent consolidation in the SMRS industry illustrates, as did cellular consolidation before it, that the efficient scale of mobile operations is more likely to be continent-wide than statewide. While I am concerned about making the auction complex, I hope that the Commission finds a simple mechanism to allow bids on nationwide licenses.

### **IV. License Bandwidth**

The Commission's seven block channel plan for PCS appears to me to waste many tens of megahertz of spectrum and to provide consumers with a far less competitive market than would many other channel plans. The controversy here is between two major camps. One group claims that 40 megahertz is needed for PCS firms to be competitive. Another camp claims that, with modern technology, far less spectrum is required for efficient PCS operations. They claim that 20 megahertz channels are sufficient for economical and competitive PCS operations.

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<sup>1</sup> I note that I am not alone in this view. Another of today's panelists, Dr. Irwin Jacobs, wrote "The PCS rulemaking is probably the most important single proceeding before the Commission right now. The rules you adopt will, in addition to providing a valuable service to millions of Americans, strongly affect our nation's competitiveness."

Letter from Irwin M. Jacobs to Chairman Quello, August 24, 1993

Unfortunately, spectrum limits influence the decision. If we assume that the 120 megahertz the Commission has allocated for licensed PCS is the total spectrum for licensed PCS, then choosing 40 megahertz channels cuts in half the number of licenses that can be granted. Instead of a relatively unfettered industry with six licenses in each area, 40 megahertz channels mean that there will only be three licensees. It becomes more difficult to permit firms that are successful in other mobile radio services into PCS, even though they are well positioned to be strong competitors in the PCS band.<sup>2</sup>

My own view is with those who support 20 megahertz-wide licenses. I believe that, with current technology, there are significant reductions in operating costs as a PCS operator moves from ten to 20 megahertz of spectrum. The cost reductions in moving from 20 to 30 megahertz are less, and the cost reductions in moving from 30 to 40 megahertz are almost nil.

If you find the case of the advocates for 40 megahertz-wide PCS licenses persuasive, but ultimately unproven, put out a channel plan (such as six 20 megahertz licenses) that permits consolidation to 40 megahertz operations inside the upper and lower PCS sub-bands, should the market push for that, but permits multiple operators on 20 megahertz licenses, should that be the market choice. If there are enormous gains in going from 20 to 40 megahertz, then the auction and the post-auction market should reveal this. However, if there are no such gains, you will never know if you only auction off 40 megahertz-wide blocks.

## **V. Problems Created by the Upper/Lower Band Split**

The PCS spectrum is divided into two sub-bands (1850-1970 megahertz and 2130-2200 megahertz) which are significantly separated. This separation makes building equipment which operates on both sub-bands more difficult and expensive. In addition, I expect that there are slight differences in the radio wave propagation and building penetration between the two bands. However, I believe that these propagation differences will be small and will not be economically significant.

The band split will have important economic implications. I believe that, for many years, manufacturers will find it significantly easier to provide equipment that operates in the lower band than to provide equipment which operates in the upper band or across both bands. The lower band is close to the PCN band used in the U.K. and the lower band was the focus of PCS development in the United States. Furthermore, I am confident that developing products for the lower band will be more profitable. That band is twice as big and has fewer

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<sup>2</sup> Indeed, in a world with three 40 megahertz PCS licenses, one might argue that MCI's tie with Nextel raises substantial competitive concerns, should MCI desire a PCS license in a community served by Nextel. In contrast, giving MCI/Nextel one of six 20 megahertz-wide PCS licenses seems far more benign.

microwave incumbents.<sup>3</sup> Consequently, I expect that, in the first few years of PCS, more than twice as much radio equipment will be purchased for operation in the lower band than in the upper band. Thus, based upon both history and profit potential, I expect manufacturers to focus first on the lower band and only later make products available for the upper band.

In the long run, perhaps a decade or more from now, I expect that equipment which operates across both bands will be available at little penalty. However, by then, the structure of the PCS industry will have been largely determined. Hence, the Commission must take into account the effects of the band split on current markets as it considers its PCS rules.

The technological problems flowing from the split band have important implications for the PCS channel plan. The current seven block plan can most easily accomplish consolidation to 40 megahertz by consolidating a 30-megahertz low-band license with a ten-megahertz-wide high-band license. If such cross-band operation is difficult or uneconomic in the short run, as I expect it will be, then the only real option to consolidate to 40 megahertz is if all four upper band licenses are controlled by a single party.

## VI. Role of Standardization

A common air-interface standard would be valuable. It would allow for economies of scale in manufacturing and for the easy provision of roaming services. However, I fear that if the Commission became involved in the standardization process, consumers would be harmed and jobs would be lost. I can identify at least half a dozen different designs that are arguably reasonable candidates for a common air interface including:

- Digital cellular (TDMA, IS-54) upbanded to 2 GHz,
- Digital cellular (CDMA, IS-95) upbanded to 2 GHz,
- The European GSM/DCS 1800 design upbanded to 2 GHz,
- The ESMR MIRS design upbanded to 2 GHz,
- BellCore's WACS design, and
- The Japanese PHP architecture.

I could add more designs, but this is enough to show the difficult standards choice facing the industry. These designs vary substantially. Preferences for one design over another cannot be resolved merely by subjective testing of the system performance and analysis of the economics of each system. Rather, these system designs differ in timing of equipment availability and which market segments each serves best. Choosing a single standard will be hard. I would hate to see the FCC get involved in the standards choice process because I feel

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<sup>3</sup> The January 1992 OET report *Creating New Technology Bands for Emerging Telecommunications Technology* by Marrangoni, Campbell, Serafini, and McGowan showed that there were 9,258 microwave incumbents in the 1850-1990 MHz range and 13,035 microwave incumbents in the 2130-2150, 2180-2200 range. (p. 8, 19) This works out to a density of 66 microwave incumbents per megahertz (nationwide) in the lower band and 325 microwave incumbents per megahertz in the upper band.

that such involvement could delay PCS by years. I know of no studies or research that indicate that Commission involvement would speed decision making or lead to the choice of a better standard.

I think the Commission's current PCS technical rules, which work to protect against interference but do not mandate any specific air interface, are fundamentally sound and that fundamental soundness should be preserved.

If the Commission believes that roaming serves important consumer needs, then it has two options. First, it can adopt licensing policies that facilitate grant of nationwide licenses. Second, it can recognize that cellular firms now offer a roaming alternative to most mobile users and ESMR firms are highly likely to do so in the future. Hence, consumers desiring roaming service will have a choice of at least three vendors. PCS service providers will face competition from other mobile service providers who offer roaming. If the roaming option is important to many consumers, then we can expect to see the PCS industry move quickly to provide that option.

## **VII. Location of Unlicensed PCS**

In examining the PCS channel plan, some have asked if it might be reasonable to relocate the unlicensed PCS spectrum to the higher PCS band. This has the attractive simplicity of placing all the licensed PCS in the low-band and placing all the unlicensed PCS spectrum in the high band.

However, I see substantial problems with such a move. First, as I showed above, there are far more microwave incumbents per megahertz in the higher band than in the lower band. Thus, clearing spectrum for unlicensed operation would require five to ten times the effort in the higher band than in the region originally designated (1890-1930 megahertz). Second, moving the unlicensed PCS up to the higher band would eliminate many of the complementarities that would flow from the unlicensed PCS being adjacent to the licensed PCS. It is possible to imagine a wireless handset that works as a cordless extension in the home or office and as a terminal for licensed PCS service when the user is out of the home or office. Building such equipment will be significantly easier if the unlicensed PCS spectrum is close to the licensed PCS spectrum. Third, I believe that firms have already put significant effort into developing products that operate in the unlicensed spectrum that is available under the current rules. Moving the band would waste much of these efforts.

I think that unlicensed PCS is a key part of the future of PCS. In my 1991 statement at the PCS *en banc* hearing I pushed strongly for an "open entry" policy in PCS that would accommodate a wide variety of firms and applications. I think the FCC's current rules for unlicensed PCS have a good chance of providing such an entry opportunity. I can foresee a wide variety of applications served by unlicensed PCS including wireless LANs, Internet connectivity for personal equipment at airports and hotels, cordless PBXs, cordless pay



telephones at convenience stores and service stations, and perhaps even wireless drops for plain old telephone service. No doubt some of these will not be realized, but others will.

A quick thought on the political environment. Unlicensed PCS is a service of enormous value to consumers—but one which does not provide concentrated opportunities to many other players. Wireless PBX extensions are nice, but competition in the PBX industry will cause most of the benefits of new wireless PBX products to be captured by consumers. Nomadic computing and widespread wireless connectivity for personal computation devices promises to bring benefits to many. But, these services will provide no long-run competitive edge for Apple against Microsoft or for Intel against Motorola. Rather, competition in the supply of unlicensed PCS equipment will serve consumers. This is unlike the situation in licensed PCS. Firms that believe themselves well-positioned to offer licensed PCS services, say, because they control an important complementary resource such as a cable system, have a concentrated interest in seeing the FCC adopt PCS rules. Unlike the case with some issues, the FCC cannot make sound policy for unlicensed PCS if it merely listens to the claims of interest groups. Some points of view, most notably that of the consumer of unlicensed PCS services, will be under-represented.

### **VIII. Impact of Incumbents**

Given the FCC's recent decision regarding public safety incumbents, no incumbents pose a long-run problem for PCS. However, full implementation of PCS will require that about 20,000 microwave systems be moved to other spectrum or replaced by other technologies. If we assume that it costs, on average, \$100,000 to move or replace a microwave system, then we get a total bill for this process of two billion dollars or about eight dollars per POP (for all PCS channels throughout the nation). I believe that this number may turn out to be high. Some microwave systems will be in areas where PCS can be engineered around the microwave system without causing interference. Other microwave systems will be able to be modified (through the addition of improved antennas and front-end filters) to be more interference rejecting at relatively low cost. Once this is done, it may be possible to engineer PCS systems to operate around these microwave systems for some time to come.

Notice that, at least to a first approximation, it really does not cost the PCS operator anything to remove the microwave incumbents. Consider a PCS license region that has ten incumbent microwave systems, each costing \$100,000 to relocate for a total cost of one million dollars to clear the license. Suppose further, that you value this license, when cleared of incumbents, at ten million dollars. What is the most you would bid for this license in an auction tomorrow? Answer, nine million dollars—what it is worth when cleared minus the cost of clearing it. Firms are doing studies of the microwave incumbents and are preparing tools to help PCS auction bidders understand the impact of microwave incumbents on the value of

PCS licenses. This information will be available to all bidders and should result in bid adjustments.<sup>4</sup>

Nevertheless, reaching an accommodation with the microwave incumbents may create delays and imposes some uncertainty. It takes some time to engineer a new microwave system. This engineering task must be put in perspective. Above, I showed that there were about 66 microwave incumbents per megahertz (nationwide) in the lower PCS band. Thus, a 20 megahertz license block would encompass about 1,300 microwave licenses throughout the whole country. If this block is licensed in 51 MTA-like geographic regions, then there will be, on average, 26 microwave systems that must be relocated or re-engineered to accommodate a PCS system. In contrast, an MTA-wide PCS system would probably have to design and build several hundred radio sites. Those cell sites require site acquisition as well as engineering. Microwave may be used to connect many of those cell sites to the switching center. All things considered, designing the PCS system will be a substantial engineering undertaking. Re-engineering the incumbent microwave systems will be a much smaller, more easily accomplished task than engineering the PCS system.

One argument for larger license bandwidths (30 megahertz or 40 megahertz) is that it makes it possible to engineer around the incumbent microwave systems more easily. I believe that this argument should be taken with a grain of salt. Many of the microwave systems of interest have relatively poor adjacent channel selectivity. The argument that potential interference into a ten-megahertz-wide microwave receiver blocks use of the co-channel spectrum near the microwave receiver for PCS, but that a slightly wider PCS license will allow the licensee to engineer around the receiver, seems questionable to me.

## **IX. Concluding Thoughts**

The FCC has made great progress on PCS but still has some distance to go. I think the public interest would be well served if the Commission revisited its PCS channel plan and chose one that better achieves the twin goals of efficiency and competition. I believe that relocating unlicensed PCS above 2130 megahertz would be a great mistake. Now that the Commission has determined that all microwave incumbents must ultimately agree to relocate their systems, I believe that the problem of the microwave incumbents is essentially solved.

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<sup>4</sup> Any party who, in their analysis of PCS policy issues, adds the cost of moving the incumbents to the auction price rather than subtracting it, is either confused or being misleading.